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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/820,695	03/30/2001	Si Yi Li	015290-500	4162

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EXAMINER	
OLSEN, ALLAN W	
ART UNIT	**PAPER NUMBER**
1763	

DATE MAILED: 02/23/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/820,695	LI ET AL.	
	Examiner	Art Unit	
	Allan Olsen	1763	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 December 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-3,5-7 and 9-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,5-7 and 9-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *01 June 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 3, 5-7, 9-21 and 25-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent 6,451,673 issued to Okada et al. (hereinafter, Okada) in view of US Patent 6,090,304 issued to Zhu et al. (hereinafter, Zhu).

Okada teaches etching carbon-doped low k glass through an ultra thin mask (column 5, line 58; column 7, lines 4-5). Okada teaches using a plasma comprising at least one fluorocarbon, such as C4F8, and N2 and Ar. Okada teaches that the etchant may also include a mixture of fluorocarbons, for example C4F8 and CH2F2 (column 3, lines 13-16). Okada teaches the low-k material overlies single crystalline silicon (col. 2, ln 53). Okada teaches etching openings smaller than 0.25 microns (column 3, line 51). Okada teaches filling the openings with metal after the etch step (column 9, lines 59-67). Okada teaches etching with a chamber pressure of 30-200 mTorr (column 8, line 49). Okada teaches obtaining straight and vertical sidewalls (column 5, lines 8-11). Okada teaches the mask may comprise silicon nitride (column 3, line 4).

Okada does not teach the flow ratio between C4F8 and N2. Okada does not teach an etching selectivity of at least about 5. Okada does not teach using a dual frequency plasma etch reactor with a showerhead and a bottom electrode on which the substrate is supported. Okada does not teach the substrate temperature. Okada does not teach an aspect ratio of at least 5:1.

Zhu teaches etching the same type of dielectric materials that are etched by Okada. Zhu teaches adding N2 to a CxFy fluorocarbon etchant to etch doped dielectrics (column 3, lines 28-31; column 5, line 11). Zhu teaches etching the doped dielectrics in a dual-frequency plasma etch reactor with a showerhead and a bottom electrode on which the substrate is supported and maintaining a temperature of below 50° C (column 5, lines 2-5; column 6, Table B). Zhu teaches that a selectivity of greater than 5:1 can be obtained, relative to overlying and underlying layers such as silicon nitride (column 8, line 8). Zhu teaches that an aspect ratio of 6:1 can be obtained (column 8, lines 7-10).

It would have been obvious to one skilled in the art to supply a greater amount of N2 than C4F8 to Okada's etching method because Okada is silent with regard to the flow rate ratio between N2 and C4F8, however, in a process similar to that of Okada, Zhu teaches using more N2 than C4F8. It is also noted that Okada teaches replacing Ar with a lighter inert/carrier gas. While Okada specifically teaches using He or Ne in lieu of Ar, the examiner notes that N2 is also known as a plasma carrier gas an N2 satisfies Okada's condition that the carrier gas be lighter than Ar. Furthermore, it would have been obvious to one skilled in the art to optimize process conditions, such as flow

rates and temperatures, in order to maximize the selectivity between the mask and the carbon-doped dielectric because Okada teaches using an ultra-thin masking layer and without a very high selectivity, the mask would be eroded before the etching process was completed. Additionally, it would have been obvious to one skilled in the art to etch features with aspect ratios of at least 5:1 because Okada teaches that high aspect ratios can be obtained and Zhu explicitly teaches that an aspect ratio of 6:1 can be obtained. It would have been obvious to one skilled in the art to use a dual-frequency plasma etch reactor with a showerhead and a bottom electrode, on which the substrate is supported, because Okada is silent with regard to the type of plasma reactor that is to be used and a dual-frequency reactor having a showerhead and a bottom electrode, on which the substrate is supported, is a common plasma reactor and it is the type of reactor that is used by Zhu to carry out a similar process.

Okada and Zhu do not teach using an etchant comprising C5F8.

It would have been obvious to one skilled in the art to use C5F8 as the fluorocarbon etchant in place of C4F8 because Zhu teaches using perfluorocarbons with the general formula of CnFm. Zhu cites C3F6 and C4F8 as examples but the extension to C5F8 is obvious because there would be no point in providing a general formula of CnFm if the only envisaged fluorocarbons were the two that were explicitly cited. C5F8 is obvious as a choice for a CxFy etchant because, as is evident in much of the prior art of record, C5F8 is well known as an etchant and it is considered a functional equivalent of C4F8.

Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Okada and Zhu as applied to claim 1 above in view of US Patent 6,251,770 issued to Uglow et al.

The combination of Okada and Zhu teach that high selectivity is obtained relative to an underlying layer of SiN.

Okada and Zhu do not teach an underlying layer of silicon carbide.

Uglow teaches that underlying barrier layers are typically SiN or SiC.

It would have been obvious to one skilled in the art to replace the underlying SiN barrier taught by the combination of Okada and Zhu with SiC because Uglow teaches that SiC and SiN are functionally equivalent in this regard.

Claims 22-24 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent 6,506,680 issued to Kim et al. (hereinafter, Kim) in view of US Patent 6,284,149 issued to Li et al. (hereinafter, Li).

Kim teaches plasma etching a carbon-doped low k dielectric with a perfluorocarbon such as C4F8. Kim teaches that a fluorohydrocarbon such as CH2F2 may be added to the C4F8. Kim teaches that N2 may be added to the C4F8/CH2F2 mixture.

Kim does not teach that the amount of CH2F2 should not exceed the amount of C4F8. Kim does not teach a flow ratio between the combined CF gases and N2. Kim does not teach using a dual RF frequency plasma reactor.

Li teaches a process similar to that of Kim's. Li teaches adding a substantial amount of N2, and Li provides example in which the flow rate of N2 far exceeds the

claimed minimum amount. Li teaches exciting the etching gas into a plasma with the application of multiple RF frequencies (figure 8; column 8, lines 51-53 and column 9, lines 2-5).

It would have been obvious to one skilled in the art to use more C4F8 than CH2F2 because Kim teaches that C4F8 may be used alone or with CH2F2. As such, the skilled artisan would view C4F8 as the primary gas that is supplemented with CH2F2. It would have been obvious to one skilled in the art to use a CF gas flow rate that was lass than or equal to 30 % of the N2 flow rate because Kim is silent in regard to the N2: CF gas ratio and Li teaches that using substantial amount of N2 prevents retrograde etching. Furthermore, N2 is often used as a plasma diluent and it is typical to use a large excess of a diluent as this provides a greater degree of control over a process. It would have been obvious to one skilled in the art to use the dual frequency apparatus of Li because Kim is silent in this regard and Li teaches that the dual frequency apparatus provides good control over a process that is similar to Kim's.

Response to Arguments

Applicant's arguments filed December 12, 2005 have been fully considered but they are either moot in view of the new grounds of rejection or they are not persuasive.

Although applicant's arguments pertaining to Khajehnouri have been rendered moot by the new grounds of rejection, the examiner offers the following response to these arguments because the examiner believes that Khajehnouri is still quite relevant and potentially applicable in 103 type rejections. Applicant argues that Khajehnouri

discloses that by "eliminating ***oxygen*** in the etching gas mixture it is possible to form ***tapered*** openings". The examiner agrees with this assessment but it is noted that the claims are not limited to a method that creates opening with a particular sidewall profile. As such, this feature upon which applicant relies (i.e., not tapered) is not recited in the rejected claims. Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Regarding the combination of Kim and Li, applicant argues that Kim teaches adding O2 or N2 to a CxFy etchant and Li teaches adding O2 and N2 to a CxFy etchant. As such, applicant argues that this combination of references would teach an etchant comprising oxygen.

In response, the examiner notes that Kim is the primary reference and Kim teaches that N2 alone can be added to a CxFy etchant. While it is true that Li teaches adding both O2 and N2 to a CxFy etchant, it is noted that Li discusses the mechanism by which N2 assist the etching process (column 10, lines 21+). The mechanism disclosed by Li is independent of oxygen and the skilled artisan would expect the benefits to manifest in the process of Kim when Kim adds only N2 to a CxFy etchant. The examiner notes that references may be combined for adopting one specific teaching from a secondary reference. A combination of references does not imply nor require the wholesale incorporation of all aspects of the secondary reference's teachings into the teachings of the primary reference.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allan Olsen whose telephone number is 571-272-1441. The examiner can normally be reached on M-F 1-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on 571-272-1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Allan Olsen
Primary Examiner
Art Unit 1763